Chpt 9 Hmwk

P 277 Q 3a
287 Q 3, 4
294 Q 2, 4
296 Q ~~3~~ 14, 15, 17
297 Q 26, 29

03-09-06

Chpt 9 starts here!

Chpt 9: Stoichiometry - mass relationships in a chemical rxn.

- $2H_2O \rightarrow 2H_2 + O_2$

2 mol. of ~~hydrogen~~ water → 1 mol of oxygen + 2 molec. of hydrogen.

if wanted 2 molec. of O_2 ⟹ 4 molec. of H_2O ⟹ 4 molec. of H_2.

if had $\underbrace{6.022 \times 10^{23}}_{\text{a mole of } O_2}$ molec. of O_2 ⟹ $\underbrace{1.2 \times 10^{24}}_{\text{2 moles of } H_2}$ H_2 ⟹ $\underbrace{1.2 \times 10^{24}}_{\text{2 moles of } H_2O}$ molec. H_2O.

* knowing ratios → can apply amount of moles.
⟹ molar ratios --> conversion factors

Mole to Mole Ex.

- If 3 moles of O_2 are produced, how many moles of H_2O are needed?

$$\cancel{3 \text{ mol } O_2} \cdot \underbrace{\frac{2 \text{ mol } H_2O}{1 \text{ mol } O_2}} = 6 \text{ mol of } H_2O$$

molar ratio - conversion factor comparing moles of reactants & products from the equation.

- easier to quantify in grams -->

mole to mass problem →

ex. $4.5 \text{ mol } O_2 \cdot \frac{16(2) \text{ gram } O_2}{1 \text{ mol } O_2} = \boxed{144 \text{ gm. } O_2}$

- easy to do viceversa --> mass to moles problems.

03-13-06

Mole-mole :

Ex. : $2KClO_3 \longrightarrow 2KCl + 3O_2 \uparrow$

• If 3.04 g KCl are produced, how many moles of O_2 are produced?

$$3.04 \text{ mol } KCl \cdot \underbrace{\frac{3 \text{ mol } O_2}{2 \text{ mol } KCl}}_{\text{molar ratio}} = 4.56 \text{ mol } O_2.$$

Mole-mass :

Ex : If 3.04 g KCl are produced, how many grams of O_2 are produced?
[cont. of ex. above]

$$4.56 \text{ mol } O_2 \cdot \frac{32 \text{ g } O_2}{1 \text{ mol } O_2} = 146 \text{ g } O_2$$

• $\text{mol A} \underbrace{\dashrightarrow}_{\text{molar ratio}} \text{mol B} \underbrace{\dashrightarrow}_{\text{molar mass ratio}} \text{mass g B}$

Mass-mole :

Ex. $3Mg + 2FeCl_3 \longrightarrow 3MgCl_2 + 2Fe$

• If 2.06 g of Mg react with excess of $FeCl_3$, how many ~~grams~~ mole of iron are produced?

so much extra, don't need to worry about it.

$$2.06 \text{ g Mg} \cdot \frac{1 \text{ mol Mg}}{24.3 \text{ g Mg}} \cdot \frac{2 \text{ mol Fe}}{3 \text{ mol Mg}} = 0.0565 \text{ mol Fe}$$

• If one doesn't have an excess ...

Ex. : 2.06 g Mg & 3.50 g --> find amount of moles of Fe.

--> which # to use? - have to do certain equations [later in chpt]

Mass-Mass :

Ex. [cont. of ex. above] How many grams of Fe?

$$0.0565 \text{ mol Fe} \cdot \frac{55.8 \text{ g Fe}}{1 \text{ mol Fe}} = 3.156 \text{ g Fe}.$$

☆ • $\text{mass A} \underbrace{\dashrightarrow}_{\frac{1 \text{ mol A}}{n \text{ g A}}} \text{mol A} \underbrace{\dashrightarrow}_{\frac{\# \text{ mol B}}{\# \text{ mol A}}} \text{mol B} \underbrace{\dashrightarrow}_{\frac{n \text{ g B}}{1 \text{ mol B}}} \text{mass B}$

molar mass — molar ratio — molar mass.

03-16-06 Limiting Reaction

- $2AgNO_3 + BaCl_2 \longrightarrow 2AgCl + Ba(NO_3)_2$.

If 5.0 g of $AgNO_3$ react with $\underbrace{\text{an excess}}_{\text{plenty of the reactant}}$ of $BaCl_2$, how many g of AgCl are produced?

→ don't have to worry about it.

→ new question: If 5.0 g of $AgNO_3$ react with 4.0 g of $BaCl_2$, how many g of AgCl are produced?

$$\underbrace{2AgNO_3}_{5.0\,g} + \underbrace{BaCl_2}_{4.0\,g} \rightarrow \underbrace{2AgCl}_{?\,g} + Ba(NO_3)_2$$

- limiting reactant (AKA limiting reagent) - the reactant that runs out 1st → thus stopping the rxn.

- excess reactant - the reactant in abundance that will not run out 1st.

Steps for a Limiting Reactant Problem

1) convert both amounts to moles.

Ex: • $5.0\text{ g } AgNO_3 \cdot \dfrac{1\text{ mol } AgNO_3}{170\text{ g } AgNO_3} = 0.0294\text{ mol } AgNO_3$ have *

• $4.0\text{ g } BaCl_2 \cdot \dfrac{1\text{ mol } BaCl_2}{208\text{ g } BaCl_2} = 0.01923\text{ mol } BaCl_2$ have *

*needs.

2) Pick one reactant & use a molar ratio to see how much of the other reactant one [needs].

Ex: $0.0294\text{ mol } AgNO_3 \cdot \dfrac{1\text{ mol } BaCl_2}{2\text{ mol } AgNO_3} = 0.0147\text{ mol } BaCl_2$ need

⟹ have more than that

⟹ $AgNO_3$ is the limiting Reactant!

3) compare moles of reactant [need to what one has]

- if one has plenty

03-20-06

Limiting Rxn

EX: $2AgNO_3 (aq) + BaCl_2 (aq) \rightarrow 2AgCl \downarrow + Ba(NO_3)_2$

(A) 5.0 g $AgNO_3$

(B) & 4.0 $BaCl_2$

} produce how many grams of AgCl.

Step 1: convert both to moles.

- 5.0 g $AgNO_3$ --> 0.0294 mol $AgNO_3$ (have)
- 4.0 g $BaCl_2$ --> 0.0192 mol $BaCl_2$ (have)

Step 2: pick one reactant (A) & see how many moles of other reactant (B) are needed.

- $0.0294 \text{ mol } AgNO_3 \cdot \frac{1 \text{ mol } BaCl_2}{2 \text{ mol } AgNO_3} = 0.0147 \text{ mol } BaCl_2$ (needed)

Step 3 compare moles needed of reactant (B) to moles have of reactant (B) of reaction.

- if you have more "B" than you need => B is the excess & A is the limiting reactant.

for EX. => (A): limiting reactant & (B) is excess reactant.

- if you have less "B" than you need => B is the limiting reactant & A is excess.

Step 4: do all calculations with limiting reactant.

$0.0294 \text{ mol } AgNO_3 \cdot \frac{1 \text{ mol } AgCl}{1 \text{ mol } AgNO_3} \cdot \frac{143.5 \text{ g } AgCl}{1 \text{ mol } AgCl} = \boxed{4.22 \text{ g } AgCl}$

EX 2: $2Fe + 3CuSO_4 \rightarrow Fe_2(SO_4)_3 + 3Cu$

- If 4.52 g of Fe react with 2.78 g $CuSO_4$, (a) how many grams of Cu are produced?

→ (b) how much excess reagent is leftover? (in grams)

- $4.52 \text{ g Fe} \cdot \frac{1 \text{ mol Fe}}{56 \text{ g Fe}} = 0.0807 \text{ mol Fe}$ have
- $2.78 \text{ g } CuSO_4 \cdot \frac{1 \text{ mol } CuSO_4}{159 \text{ g } CuSO_4} = 0.0175 \text{ mol } CuSO_4$ have

- If pick Fe --> $0.0807 \text{ mol Fe} \cdot \frac{3 \ CuSO_4}{2 \text{ mol Fe}} = 0.12105 \text{ mol } CuSO_4$ need => don't have it!

=> $CuSO_4$ is the LR.

- $0.0175 \text{ mol } CuSO_4 \cdot \frac{3 \text{ mol Cu}}{3 \text{ mol } CuSO_4} \cdot \frac{63.5 \text{ g Cu}}{1 \text{ mol Cu}} = \boxed{1.12 \text{ g Cu}}$ (a)

(b) How much ER is leftover?

0.0807 mol Fe have - [how much needed]

→ $0.0175 \text{ mol } CuSO_4 \cdot \frac{2 \text{ mol Fe}}{3 \text{ mol } CuSO_4} = 0.0117 \text{ mol Fe}$ used

=> $0.0807 \text{ mol Fe} - 0.0117 \text{ mol Fe} = 0.0690 \text{ mol Fe} \cdot \frac{56 \text{ g Fe}}{1 \text{ mol Fe}} = \boxed{3.87 \text{ g Fe}}$

03-23-06

Percent Yield = $\frac{\text{actual yield (amount of product from experimentation)}}{\text{theoretical yield (calculated yield)}} \cdot 100\%$

Ex: If 4.0 g of sodium sulfate reacts with an excess of calcium chloride, what is the percent yield of the ppt if only 0.800 g of it are produced?

$$Na_2SO_4 + CaCl_2 \longrightarrow 2NaCl + CaSO_4 \downarrow$$

$$4 \text{ g } Na_2SO_4 \cdot \frac{1 \text{ mol } Na_2SO_4}{142 \text{ g } Na_2SO_4} \cdot \frac{1 \text{ mol } CaSO_4}{1 \text{ mol } Na_2SO_4} \cdot \frac{136 \text{ g } CaSO_4}{1 \text{ mol } CaSO_4} = 3.84 \text{ g } CaSO_4$$

↳ theoretical yield.

- percent yield = $\frac{0.800 \text{ g}}{3.84 \text{ g}} \cdot 100 = \boxed{20.8\%} \rightarrow \boxed{21\%}$